The response of belowground carbon turnover and heterotrophic microbial communities to warming in peatlands at the ecosystem scale.

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High latitude peatlands store approximately 1/3 of all soil carbon(C), but wetland-specific processes are underrepresented in global climate models. Using advanced analytical chemistry, ^{14}C and ^{13}C tracing, and next generation gene sequencing, this project quantifies the response of soil organic matter (SOM) storage, reactivity, and decomposition, and the functional diversity of microorganisms to climate change manipulation in peatlands. The project is being conducted at the Marcell Experimental Forest(MEF), northern Minnesota, where the Oak Ridge National Lab (ORNL) has established an experimental site known as Spruce and Peatland Response Under Climatic and Environmental Change (SPRUCE). In collaboration with SPRUCE investigators at ORNL, new insights will be incorporated into the land component of the Community Earth System Model to improve climate projections.

From June 2014 to June 2015, an experiment known as Deep Peat Heating (DPH) was conducted at SPRUCE whereby soil heating alone was initiated to >2 m depth. Our group evaluated the response of the belowground C cycle and microbial communities in 5 soil warming treatments(+0°C; +2.25°C; +4.5°C; +6.75°C; +9°C). To verify the role of surficial processes in the field CH_4 flux response, we compared the natural abundance $\Delta^{14}C$ of the porewater dissolved organic carbon (DOC), CO_2 (DIC), and CH_4 with the solid peat. In all plots and depths, the $\Delta^{14}C$ of CH_4 and DIC were relatively young, ^{14}C-enriched relative to the peat, and indistinguishable from the $\Delta^{14}C$ of the DOC. This is consistent with respiration fueled by recent primary production rather than degradation of older catotelm C. The young age and lack of a temperature effect on DOC concentrations belie significant leaching of catotelm C into the dissolved pool after 13 months of warming. The concentration and stable C isotope composition of respiration products (DIC and CH_4) across all temperature treatments were stable within observed environmental variability, supporting the conclusion that warming did not increase deep peat C mineralization. Findings from radiocarbon chemistry are corroborated by parallel analysis of the in situ microbial communities. While microbial community structure and abundance were stable across all temperature treatments, strong vertical stratification was observed in parallel with geochemical evidence of peat decomposition state, corroborating our baseline data published from S1 bog. The potential activity of extracellular oxidative enzymes (phenol oxidases and peroxidases) was also consistent across temperature treatments and years. Our initial results indicate that the large store of deep catotelm C will be resistant to anaerobic degradation under future climatic warming.